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The development cycle of *Bunodera luciopercae* (O. F. Müller)

Cykl rozwojowy *Bunodera luciopercae* (O. F. Müller)

I established the development cycle of *Bunodera luciopercae* (O. F. Müller) in two periods at a long interval.

I established it for the first time during my research on the cercariae of Polesie in 1939. I found a metacercaria of the group *Ophthalmoxiphidiocercariae* in *Sphaerium rivicola* Lamarck then. I also found a metacercaria of this group in plankton cellected in the River Lwa. As there were processes in the oral sucker of the metacercaria characteristic of *Bunodera luciopercae* and as the species was common in the fish (*Perca fluviatilis* L., *Acerina cernua* L.) coming from the same river, I suspected that the cercaria found in *Sphaerium rivicola* and the metacercaria found in plankton were juvenile forms of these species. To prove my supposition that they were fragments of the cycle of this species I brought about an experimental invasion of the intermediate hosts with the cercariae and later on that of the fish by the intermediate hosts. Positive results of the experiments assured me that the forms found really represented fragments of the cycle of *Bunodera luciopercae*.

I was able to verify my findings concerning the life cycle of *Bunodera luciopercae* when I examined the parasitofauna of the Mazury Lakes. I examined the parasitofauna of Lake Drużno in 1953, that of Lake Gołdapiwo in 1954—55 and that of Lake Mamry Północne in 1956 and I succeeded in finding the primary host — *Sphaerium corneum* and the intermediate host in the plankton of those lakes. My examination of the parasitofauna also enabled me to extend the list of intermediate hosts by adding those occurring in an eutrophic and a mezotrophic lake to those found experimentally.

Here is the development cycle: *Sphaerium rivicola* Lamarck and *Sphaerium corneum* L. are primary hosts, *Daphnia pulex* (de Geer), *Simocephalus expinosus* (Koch), *Eurycercus lamellatus* O. F. Müller and *Notodromas monacha* O. F. Müller are intermediate hosts found experimentally; *Mesocyclops oithonoides* Sars is an intermediate host found in an eutrophic lake (Drużno) and *Mesocyclops crassus* (Fisch.) is an intermediate host found in mezotrophic lakes (Gołdapiwo, Mamry Północne). Both *Copepoda* species are closely related to each other both through morphological features and the way of living. They live in the littoral and *M. oithonoides* may also occur in the pelagial and non-overgrown littoral.

I made the first experiments in invading the intermediate hosts with the cercariae at Lubowiże Forest Lodge near Stolin, Polesie in the summer 1939. The object of invasion was *Daphnia pulex*. I tried the experiment because I had found a specimen invaded by *Ophthalmoxiphidiometacercaria* in the plankton from the River Lwa. The metacercaria must have stayed in the host for some time before as the wall of the cyst was thickened and there were processes characteristic of *B. luciopercae* on the oral sucker. When examining the plankton I found a similar cercaria in *Cyclops* sp. As I had plenty of uninvaded *D. pulex* specimens from a forest well near by at my disposal I used some of those before any others as an object to invade. The cercariae used in the experiment came from *Sphaerium rivicola* collected from the River Lwa. I kept them in a crystallizer together with *Daphnia* when I made sure that the lamellibranchiates were invaded by the cercariae. The invasion yielded a positive result.

By keeping the invaded lamellibranchiates with the *Daphnia* I had a supply of intermediate hosts for further experiments with fish and the morphological examination of the metacercariae. Thus I was able to follow the changes taking place in the metacercariae from the moment of their invasion into the hosts to the stage when the metacercaria had already features characteristic of young *B. luciopercae* and when it was found in fish.

I made my experiments in invading final hosts in Polesie as well in 1939. I used *Acerina cernua* for them. As the fish came from the River Lwa I could not be sure that they had not been invaded naturally before. Consequently I used a great number of *Daphnia* invaded by metacercariae so that the number of juvenile forms could be a sure

proof of the experimental invasion. The result was also positive here as shown in the description of the experiment given below.

Six *Acerina cernua* were used in the experiment which had been kept unfed for a fortnight before. On August 24th and 27th they were fed with some invaded *Daphnia pulex*. Both times they were given a portion of 100 specimens in all. There were several metacercariae in each of the *Daphnia*. The fishes were examined in five days (on Aug. 29th) and in the meantime uninvaded *Daphnia* were given to the fish to eat. *B. luciopercae* was found in all six *Acerina cernua* examined (Table I).

Table I

Results of the experimental invasion

Fish number	Number of flukes found	Size of *B. luciopercae*
1	30 2	0.20—0.50 0.90—1.20
2	23 2	0.20—0.50 0.90—1.20
3	7 1	0.30—0.50 1.50—1.80
4	3	0.20—0.50
5	2 2	0.30—0.50 1.50—1.80
6	1 2	0.30—0.50 1.50—1.80
	Control fishes	
1—3	—	— —
4	2	0.90—1.40

It follows from a comparison of the fishes used for experiment with the control fishes that the fishes taken for the experiment might have been naturally invaded. In one out of the four control fishes two specimens of *B. luciopercae* 0.90—1.40 mm in size were found. The stages of the parasites over 0.90—1.40 mm could not come from the experimental invasion. Far younger specimens were obtained in the experiment which varied from 0.20 to 0.50 mm in length. They did not differ in size from the metacercariae occurring in *D. pulex*. The parasites obtained, the smaller ones, 0.20 to 0.50 mm long at least, could be held to come from the experimental invasion. This is suggested by the small size of the flukes, the low degree of development, the 100 per cent invasion and a generally high number of juvenile forms found in the fishes (30, 23, 7, 3, 2, 1). There were few of them (2 to 5) in fishes comming from a natural environment.

The outbreak of the war in 1939 made it impossible for me to continue my research and especially to repeat the experiment, to try

to find other intermediate hosts and to verify my findings in a natural environment. I resumed the research after the war when I examined the parasitofauna of Lakes Drużno, Gołdapiwo and Mamry Północne. I was able then to discover new intermediate hosts experimentally and make more extensive observations on intermediate hosts in a natural environment. Thanks to the repeated experiment I was able above all to find out that in addition to *D. pulex* also other species of *Cladocera (Simocephalus expinosus, Eurycercus lamellatus)* and *Ostracoda (Notodromas monacha)*, and in the lake biocoenosis some species of *Copepoda* were intermediate hosts. The results of the experimental invasion is shown in Table II.

Table II

Experimental invasion of representatives of *Cladocera, Ostracoda, Copepoda*

Intermediate host	Date of invasion	Number of hosts	Date of examination	No. of specimens invaded	No. of metacercariae
Daphnia pulex	July11 1955	3	July17 1955	3	7
Simocephalus expinosus	„	15	„	13	30
Eurycercus lamellatus	„	6	„	3	4
Notodromas monacha	„	5	„	2	2
Cyclocypris laevis	„	5	„	—	—
Macrocyclops albidus	„	25	„	—	—
Macrocyclops distinctus	„	5	„	—	—
Macrocyclops fuscus	„	5	„	—	—
Acanthocyclops vernalis	„	5	„	—	—

From the plankton of the eutrophic lake 48,600 specimens were examined including species of *Cladocera, Copepoda* and *Ostracoda*. Only ten *Mesocyclops oithonoides* invaded by *B. luciopercae* metacercaria were found in the number. Jarecka examined 38605 specimens of *Cladocera, Copepoda* and *Ostracoda* at Lake Gołdapiwo and found only one metacercaria of the species. She examined 12667 specimens of the plankton of Lake Mamry and also found one cercaria in them. Only *Mesocyclops crassus* proved to be the host in both lakes. These findings show that the intermediate host in scattered throughout the fauna of the lakes.

Description of cercaria

Dimensions: 0.14 — 0.35 × 0.06 — 0.04 + 0.15 — 0.30 mm.

The dimensions are given in the following order: length of body by width of body + length of tail. They are given for the maximum extension and maximum contraction.

The cercaria shows a fairly great mobility and consequently a great variability of shape. When extended (0.30 — 0.35 × 0.05 mm) assumes the shape of an elongated rod even in width and when contracted (0.14 × 0.12 mm) becomes considerably shorter and wider and has the shape of a pear (Fig. 1). The cercaria is mobile not only when staying in water but when transferred from water on the slide. Its natatory movements are limited then as it gets adhered to the surface of the glass by means of the secretion of the ventral sucker.

The natatory movements in water are rapid and resemble those made by *Xiphidiocercaria*, so the body is arched ventrally, the tail draws the sign of infinity and consequently the body pendulates both ways. The swerves of the body to the left and right follow one another very fast. The cercaria swims very persistently. The periods of rest are short and they are no spans of immobility. Instead of making natatory movements the body contracts and extends and swerves left and right, while the natatory movements change into creeping ones. The cercaria moves in one direction on the slide then and sinks inert in the vessel with water but before it reaches the bottom it starts swimming again.

A cercaria consists of two parts, the body proper and the tail. The tissue of the body is hardly transparent; of all organs only both suckers, eyes, pharynx and excretory canals are distinctly visible. The little transparence of the body of the cercaria is due to its being filled with a great number of cells with fine granular plasm. These cells make the internal organization obscure and make it difficult to decide which glands are penetrative, cystigenous, parenchymatous or otherwise.

The oral sucker is somewhat larger than the ventral one, although at times their dimensions are the same or even those of the latter are larger.

Oral sucker, 0.045 — 0.064 × 0.048 — 0.040 mm.

Ventral sucker, 0.048 — 0.055 × 0.055 — 0.038 mm.

The above figures stand for the varying length and width.

In some cases the ventral sucker seems to be bigger than it is in reality. This appearance is due to the secretion of the ventral glands, drops of which surround the sucker making its circumference seem larger (Fig. 1). The sucker openings are distinct. The shape of the suckers is very changeable. One and the same oral sucker measured 0.048 × 0.048 mm first only to extend to 0.052 × 0.052 mm a moment later. The ventral sucker is even more changeable, which is due to the occurrence of glands in it and its extension when it adheres to the surface of the slide or cover glass.

The oral opening appears very distinct in the oral sucker, as it has frequently a double border although the alimentary tract is not fully developed in cercaria. There is a spine above it in the front part of the sucker. It is short (0.016 — 0.017 mm), wide, full and has a cylindrical extension before its pointed termination (Fig. 3). It is distinctly different from that in *Xiphidiocercariae*, in which the centre of the stiletto is typically hollow.

The ventral sucker lies behind the centre of the body. Owing to its great mobility, variability in shape and size it may extend outside the body at a considerable distance. There are glands inside the sucker which help the cercaria to get inside the intermediate host. They consist of smallish piriform cells with fine granular plasm. The secretory character of the cells may be easily known from the tensile substance secreted by them and settling in drops on the circumference of the sucker (Fig. 2). The cells might seem to fill the whole of the sucker and making up all its content. The mobility of the sucker however suggests the occurrence of muscle fibres in it although I was not able to observe them in a living cercaria in those conditions. Glandular cells are fairly numerous. No nuclei of cells may be seen in any full grown and mature cercaria because they are filled with secretion and become granular in character. The period during which the cercaria swims in water helps drops of secretion to appear. This is a phenomenon observed in very many cercariae, e. g. the appearance of grains of secretion in the penetrative and cystigenous glands. The secretion of the ventral glands appears in *B. luciopercae* cercariae. Accordingly, the border of the opening of the ventral sucker becomes very distinct, refracts light more strongly and on a strip of its surface drops of secretion begin to come out. The secretion penetrates and gets through the cuticle as is typical of cystigenous secretion in other cercariae. The secretion coming out may coagulate into small droplets and these

may form a wreath around the opening of the border of the sucker. In other cases they form a hood roofing part of the sucker. The border of the sucker is mobile, it gets narrow and wide, shifts regularly to the front and the back of the body and this makes its appearance vary, particularly in the part forming a section of the opening of the sucker. Among other things the period of secretion indicates that a cercaria is mature, i. e. may penetrate into its intermediate host.

The secretion settles in droplets occurring throughout the surface of adhesion of the sucker and this suggests the idea of applying the secretion practically. As is known various species of plankton crustaceans swimming rapidly and making violent jumping movements are intermediate hosts. The viscous secretion issuing on to the surface of adhesion in the ventral sucker helps a cercaria stick to the host. It is difficult to detach a cercaria from the slide. When I invaded *Daphnia pulex* experimentally I was able many times to catch a cercaria when it was getting into the body cavity of the host. It remained adhered to the carapax of the crustacean and although fingered and touched it could not get off the surface. It follows from this observation that the secretion helps a cercaria to get attached to a mobile host and penetrate into its body cavity. The sucker extrudes fairly far outside the body and there are glands in it, which shows the accommodation of the same category intended to help a cercaria get into its host.

The penetrative glands lie on both sides of the body, in the middle section, often before the sucker, in pairs. They are made of small cells hardly distinct from others. There are three pairs of them in a mature cercaria. They differ from those in other cercariae neither in size nor in the character of the plasm. The presence of thin ducts alone makes them differ from other cells. The glandular ducts run towards the oral sucker, between the eyes, and terminate near the termination of the spine in the oral sucker. The penetrative glands are more distinct in metacercariae, as their protoplasm is somewhat different from that of other cells. There appear eight pairs of glandular cells in a metacercaria. Probably the number is higher in a cercaria as well than it was possible to determine, the outlines of these cells being vague and obscure. In immature forms unable to live in water and remaining in the tissue of *Lamellibranchiata* the glandular cells and efferent ducts are also more distinct than in mature forms, but I was not able to count any higher number of them. In the period

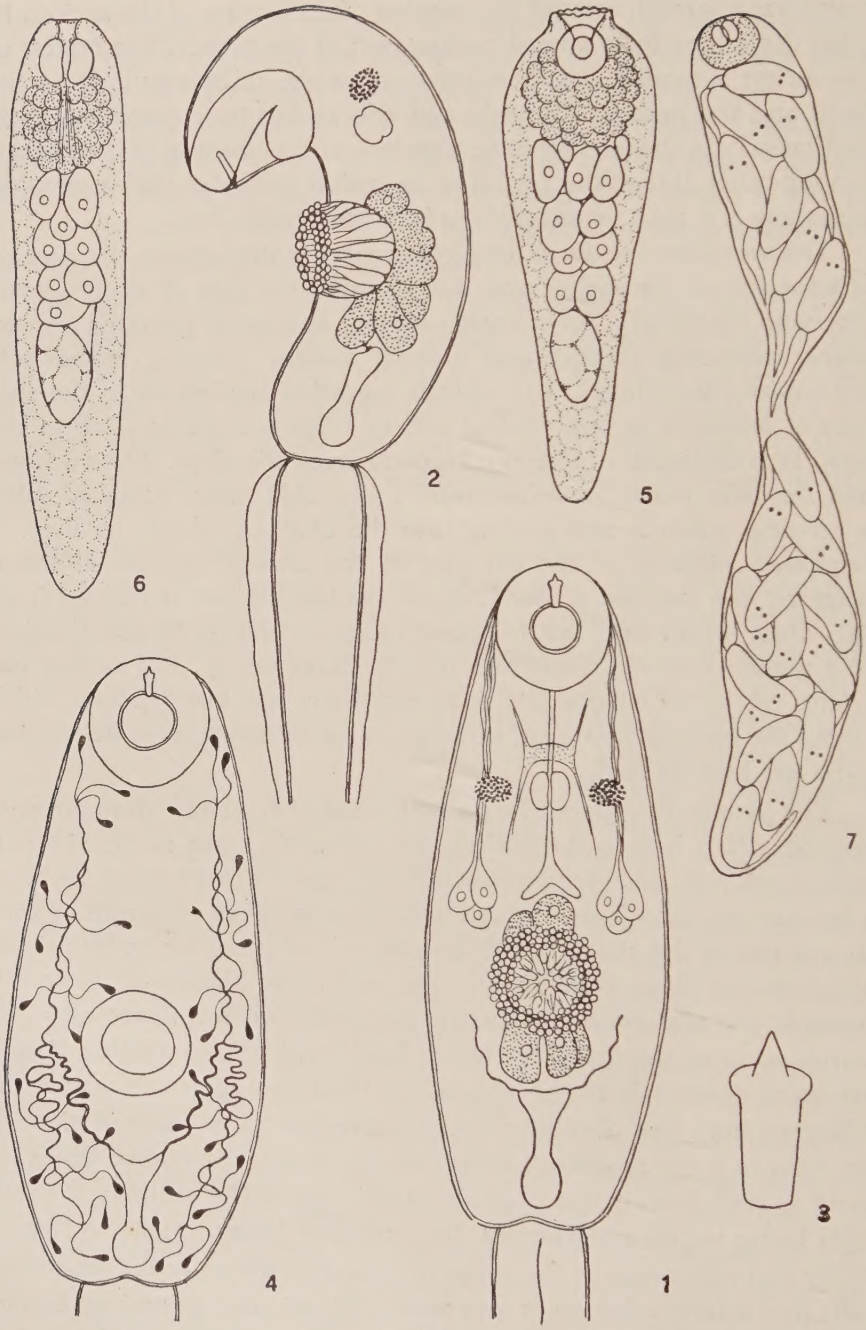

Fig. 1—7. Cercaria *Bunodera luciopercae*. 1. Ventral view. 2. Lateral view. 3. Stiletto. 4. Excretory system. 5, 6, 7. Rediae in various stages of development.

when their activity is the strongest and the highest demands are made on their function in other cercariae, they are comparatively less visible than at any other time.

The alimentary tract is only partly developed. There runs a long and narrow praepharynx from the oral opening and passes into a well-developed and large pharynx (0.023 × 0.020 mm). It lies considerably far from the oral sucker at the same height as the eyes. An oesophagus, just as narrow as the praepharynx, is an extension of the pharynx. It forks in front of the ventral sucker into very short intestinal branches. No part of the alimentary tract is functionally active as there is no lumen of the ducts. Short intestinal branches and lack of lumen in the ducts prove that the formation of the intestine is not yet completed.

There appear a pair of large dark or black eyes in the front part of the body. They lie at the height of the pharynx, one on either side, and are made of many fine grains of pigment. The eyes are very distinct and appear already in redia. They remain there for a long time and disappear only in the final host as a rule.

The initial part of the excretory system, the „vibratory flames", are hardly visible (Fig. 4). They are situated in the front and hind parts of the body rather unevenly as they are denser behind the ventral sucker than in the front part. Besides, the „flames" lying centripetally seem to be larger than those lying peripherally on the sides of the body. They occur in threes and the excretory formula reads: $2[(3 + 3 + 3) + (3 + 3 + 3)] = 36$. There is a narrow duct running from each of the „flames". The ducts of three „flames" join into one and pass into a duct of the first order. There are three ducts of the first order in the fore part and in the hind part. At about the height of the hind border of the ventral sucker the ducts of the first order join one another and form ducts of the second order which pass into the excretory vesicle. This has the shape of an elongated canal consisting of the fore and hind parts filling up alternately. The whole of the vesicle was seldom full-up. Thanks to brighter light refraction the excretory vesicle and the ducts of the second order are more visible than any other part of the excretory system. Its visibility depends on the amount of excretory liquid filling the lumen of the ducts.

On the dorsal side of the body before and partly behind the ventral sucker there is a compact group of cells roughly in the shape of

an inverted Y and visible in a living cercaria. When the body moves it partly changes its position in relation to the sucker by shifting on its sides. All cells are irregular in shape, their plasm is of large grains and thus the whole sets off against the surrounding. This formation is regarded as the anlage of the reproductive ducts, the odd section sticking before the sucker constituting the anlage of the masculine copulative apparatus, while the forking section sticking behind the sucker is probably the anlage of the uterine ducts (Fig 1, 2).

There is a fragment of the nervous system visible near the pharynx. A cerebral coil may be seen at the top from which processes run towards the oral sucker and eyes and two nerve branches towards the hind part of the body.

The tail reaches about the length of the cercaria body but is narrower. It is wider at the socle than elsewhere and it narrows from the socle towards the end. The longitudinal and circular muscular cells are independent of the muscular cells situated in the body. The cuticle of the tail is thick and passes into a fin on the dorsal and ventral sides. The fin is low, it is not striking and may be noticed only when the tail has turned aside (Fig. 2). It is more distinct near the base of the tail and disappears about two-thirds through its length.

The cercaria develops in rediae. These are like long, comparatively narrow saccules with no intestine, no collar and no procruscule (Fig. 5, 6). They look more like sporocysts than rediae. The nature of redia may be recognized more distinctly in a young one in which also a pharynx surrounded with tissue is distinct. Small rediae (0.18 — — 0.20 × 0.06 mm in length) have a pharynx 0.030 — 0.040 mm in size. Cells are linked to the pharynx which resemble glandular cells in appearance. They occupy the site of the intestine and almost reach half through the body. The above cells disappear in older radiae (0.70 — 1.00 × 0.10 — 0.15 mm in length) and the cavity of the redia develops instead. The cavity is filled by fine embryonic cells at first from which cercariae gradually develop. The pharynx does not grow as the whole of the redia does, so that in fully grown-up forms (1.5 — 3.0 × 0.15 — 0.23 mm in length) only a small pharynx remains surrounded with a tissue replacing the undeveloping intestine.

Mother and daughter rediae may be distinguished. They differ from each other mainly in the content of progeny, for the morphological differences are very slight. A thick cover of epithelium develops in mother rediae so that they seem to be surrounded with an extra

coat and wider. Rediae are found in one-age stages, i. e. whether mother or daughter they contain various stages of cercariae. The cercariae are distinct, particularly after they have developed eyes. The dark pigment of the eyes helps distinguish cercariae and even determine their degree of development.

Rediae have no sexual opening and the usually numerous cercariae (30 to 35) leave them when they reach larger dimensions, become narrow in one or more places and divide into smaller saccules (Fig. 7). Thus, „derivative rediae" are formed which look like sporocysts. The cercariae developing in rediae reach various stages of development. When they leave rediae they continue to develop on the leg of mussel, where they lie between the intestine and the reproductive organs. Only when they have developed fully they abandon the host to live in the water.

The excretory system in rediae consists of four „flames" distributed on the ventral side and just as many „flames" on the dorsal side in the front and back parts of the body. From each of them goes a narrow duct and these join each other to form first a front canal and then a hind one. Both canals pass in turn into an efferent canal with an exit in the middle of a redia. The excretory system of rediae is visible very seldom indeed.

Cercariae show a positive phototropism and a negative geotropism in the water. They leave the mussle in the full day-time and accumulate in the upper layers of the vessel but not right under the surface of the water. Their behaviour follows the habits of the plankton.

Metacercaria

When they have penetrated to the crustacean the tailless metacercaria begins to encyst. It lies in the body cavity of the host and does not differ from a cercaria except for having no tail and there being no secretion in the ventral sucker. In *D. pulex* it is to be found most frequently in the region of the intestine. Single specimens group in the front part of the body cavity and when there are more of them they group along the intestine. The position nearer the abdomen is less favourable from the point of view of growth, for larvae found there after a few days are checked in development. This is caused in all probability rather by congestion than position in the body cavity.

Metacercariae are easily recognizable after they penetrate to the body cavity thanks to the preserved dark eyes. The cystogenous

secretion and the formation of the cyst brings about a diminution of the body. When then measured metacercariae are 0.11 — 0.12 × × 0.079 — 0.096 mm in length, i. e. smaller than the cercariae swimming freely. Not all of them get encysted after getting into the body cavity. I found cercaria with no cyst. But its absence does not help development. When let into the water such cercariae die almost instantaneoulsy and develop no further organs as a rule. While the production of the cyst is a clear isolation from the external environment and protection from the influence of this environment, it is difficult to regard it as a manifestation of some development stimulus with which the process of encystment, is no doubt connected in some way or other. This is attested by a stoppage in developing organs in unencysted metacercariae.

There are no distinct changes in the development for the first two or three days and only after this period they begin gradually to appear.

The first changes take place in the appearance of the excretory vesicle. It grows considerably and its canalicular shape changes to a fairly large oval saccule. There are spherical formations and fine grains more strongly refracting light inside it. The cells lining the inside of the vesicle degenerate, vacuolize and swell, and granules performing Brown's movements appear in the protoplasmatic content of the cells. Thus, the inside of the vesicle increases and finally, when the cells have burst, granules accumulate in it which may be final crystallized products of metabolism. At the same time the penetrative glands become very distinct and it is easy to distinguish among them eight pairs of cells distributed on either side of the body.

Further distinct changes take place in five to six days. Muscular processes characteristic of *B. luciopercae* begin to appear in the oral sucker. They are at first of an indefinite transitory character. As they stay inside the host they become more durable and do not disappear from the oral sucker after six to seven days. There appear two processes on the ventral side, another two on the dorsal side and one on either lateral side, six processes altogether. The muscular character of the processes is obvious now. The muscular cells in the ventral sucker, which — as is known — are quite underdeveloped in cercariae, also grow and consequently the suckers become similar to those in a young fluke collected from fish (Fig. 12).

The spine is very often situated in the front part of the sucker in

a young metacercaria. But when the cercaria penetrates to the crustacean it is cast away sooner or later and lying free in the cyst it is gradually dissolved.

Further changes are very slow. The lumen appears in the intestine only within two to three weeks of the metacercaria's stay in the intermediate host. The formation of the intestine consists in that first the cells to form the future intestine form one row and when their plasm is degenerated the lumen of the duct appears. The lumen is distinct however only when the metacercaria passes into its final host.

Fig. 12. Metacercaria *Bunodera luciopercae.*

The cells forming the anlage of the reproductive organs appear only in the second or third week of the metacercaria's life. Apart from the formation of these anlages I did not follow the further development of the reproductive organs of cercariae though the metacercariae stayed in the crustacean for seven weeks. Although the development changes in metacercariae are slight, they are great enough for us to distinguish in metacercariae the distinctive features of flukes and to determine a clear transition from the cercaria stage to the stages found in fish. They never went so far that I might be able to verify on my material the statement D o l l f u s (1949) makes when he writes about *Ophthalmoxiphidiocercariae:* „elles sont parfois progénétiques". The processes of progenesis probably depend above all on the intermediate host and not on the type of cercaria.

The eyes are preserved throughout the metacercaria period. They are of no use to it, nor can they play any part during the passage to the final host as the cercaria undergoes it passively. In three weeks the eyes of the metacercaria begin to disintegrate and disappear. At first the pigment may be seen split into single tubercles and granules, yet the eyes never disappear in the intermediate host and it is possible to find them quite intact in a young fluke taken from fish.

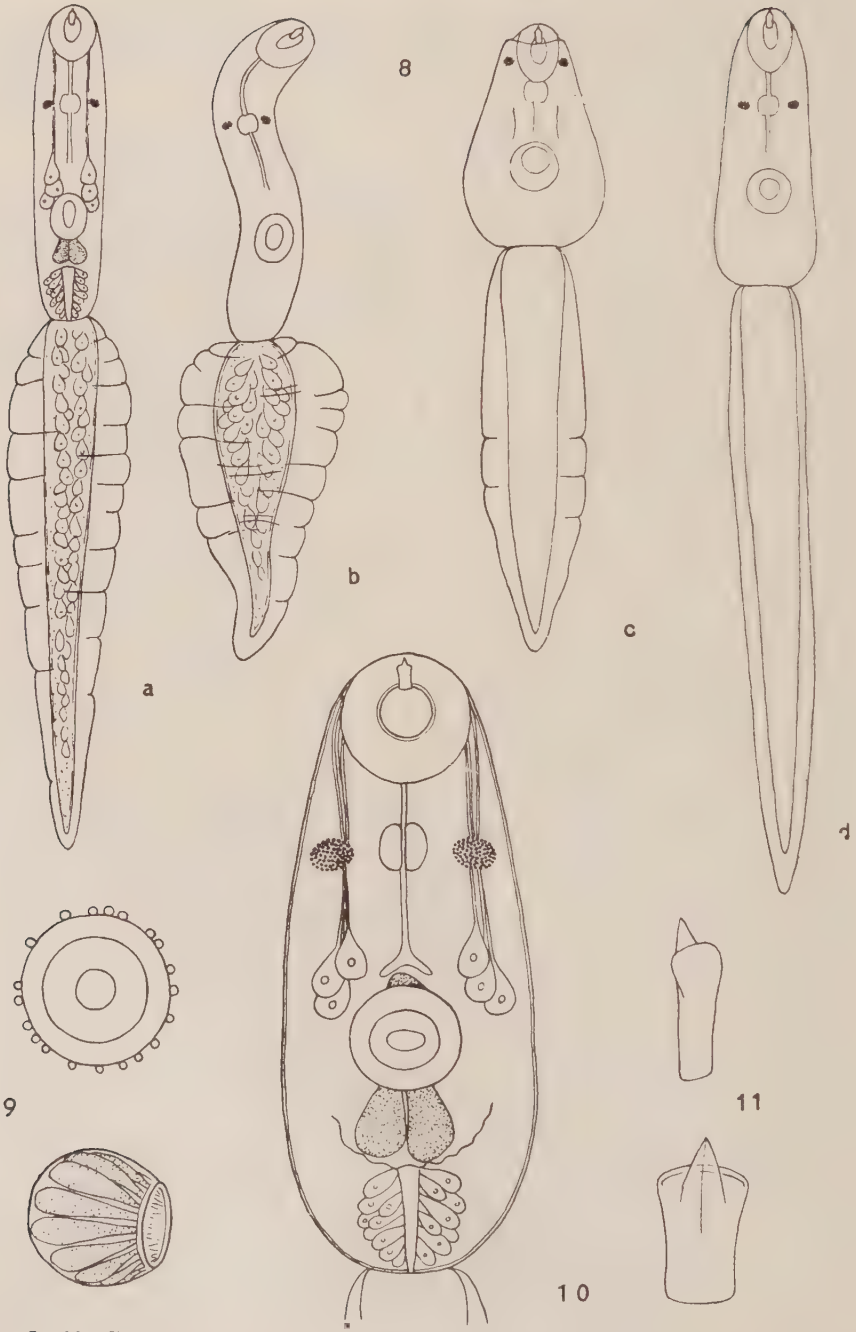

Fig. 8—11. *Cercaria isopora*. 8. Various stages of extension and contraction. 9. Glands of ventral sucker. 10. Ventral view. 11. Stiletto.

A metacercaria is able to invade fish only when it has developed processes on the oral sucker and this comes practically after a week's stay in the intermediate host. It then reaches 0.20 — 0.35 × 0.18 — — 0.063 mm in size, while the other organs measure as follows: oral sucker, 0.055 — 0.063 × 0.047 — 0.060 mm, ventral sucker, 0.051 — — 0.063 × 0.047 — 0.063 mm. So it reaches the length of the cercaria again and is much thicker than the former. Meanwhile, the parenchymatous tissue spreads and fills up gaps caused by the cystigenous secretion. The changes occurring in the histology of the body show that the metacercaria period is one of changes taking place in the morphogenesis of fluke.

Allocreadium isoporum cercaria Looss

I found *A. isoporum* cercariae in *Sphaerium corneum* and *Sphaerium rivicola* in the River Lwa in Polesie in 1937—39 and in Lakes Gołdapiwo and Mamry Północne in 1955—56. They occurred only in *Sphaerium corneum* in the lakes of the Mazury District. *A. isoporum* cercaria was first described by Looss (1894) and Lühe (1909) repeated Looss's description. Dollfus (1949) confirmed Looss's description with some slight additions. The cercaria found by Dollfus in *Sphaerium rivicola* comes from the Marne, France.

The cercaria has all of the most important and characteristic features of *Opthalmoxiphidiocercariae*. It differs form the described *B. luciopercae* cercaria mainly in the structure of the tail and the presence of the glands in the ventral sucker, which are not so distinct in it. Dimensions, 0.14 — 0.35 × 0.05 — 0.12 + 0.15 — 0.60 × 0.06 — — 0.16 mm; oral sucker, 0.50 — 0.55 × 0.55 — 0.50 mm; ventral sucker, 0.040 — 0.047 × 0.047 — 0.040 mm; pharynx 0.010 — 0.023 × × 0.018 — 0.019 mm; spine, 0.020 mm.

There are glandular cells in the ventral sucker. Their secretion comes outside and accumulates in droplets on the circumference of the sucker. The glands of the ventral sucker are less developed and visible than in *B. luciopercae* cercariae and I noticed no secretion in a cercaria swimming in the water. In connection with the oral sucker there occur penetrative glands, three pairs in number, also indistinct and situated on both sides of the front border of the ventral sucker.

The tail is surrounded with a cuticular case distinctly separated from the middle part of the tail. The case becomes wider or narrower with contractions and extensions of the tail. The case of the tail should

be regarded as the outer part of the cuticle of smaller consistence than in the body proper but far wider instead. In the middle of the tail there are muscular cells the contractions of which cause the extension, shrinking and all other movements of the tail.

The anlages of the reproductive organs are pretty well developed on the dorsal side of the body before and behind the ventral sucker.

The oral sucker is slightly larger than the ventral one. The latter lies behind the middle of the body. The praepharynx is about the length of the pharynx, the oesophagus is somewhat longer but narrow. The branches of the intestine cannot be seen. The body tissue is hardly transparent and this considerably hinders anatomical analysis. The eyes occur at the height of the pharynx on the dorsal side and are large, dark, oval and consist of fine grains of pigment. The cuticle is smooth, it wrinkles and folds in contractions. Excretory formula, $2\ [(3 + 3 + 3) + (3 + 3 + 3)] = 36$. The excretory vesicle is elongated and surrounded with a group of granular cells. As the cercaria develops it extends at the expense of other cells and becomes like a sac.

The cercariae develop in rediae, which have no intestine, collar, procruscule or sexual opening. In place of the intestine a group of cells develop situated close to each other and reaching up to the upper half of the redia. As the redia grows its front section preserves the original dimensions and so the pharynx becomes distinctly smaller. Generative cells lie behind the group of cells replacing the intestine. Later in the development they are in the body cavity of the redia and originate a cercaria generation. Compared with other rediae, these cells are large. In young rediae (0.15×0.063 — 0.27×0.045 mm) the pharynx reaches 0.030×0.030 mm.

Although its development cycle has not been determined yet, Looss suggests that it belongs to *Allocreadium isoporum* when he assigns a name to it. I for one support Looss's supposition on the virtue of the following: mature *Allocreadium isoporum* ranks with the typical representatives of fish flukes in Lakes Gołdapiwo and Mamry Północne. *B. luciopercae*, also one of *Allocreadiidae*, is another such species. Among the *Mollusca* I examined at the above Mazury lakes I found two *Opthalmoxiphidiocercariae* which in the opinion of many authors represented larval forms of *Allocreadiidae*. One of the cercariae was identified as *B. luciopercae*. Accordingly it may be assumed that the other cercaria species belongs to the other representative of *Allocreadiidae*, i. e. *Allocreadium isoporum*.

Characteristic of *Ophthalmoxiphidiocercariae*

The name *Ophthalmoxiphidiocercariae* was decided by Möller 1925), yet their affinity to *Xiphidiocercariae* is not so close as it might be judged from the name of the group. Anyhow, they cannot be assigned to *Xiphidiocercariae* as one of the groups among them. The analysis of features of *B. luciopercae* and *A. isoporum* cercariae and of other representatives of *Ophthalmoxiphidiocercariae* makes it possible to distinguish the following characteristics of this group:

(1) The excretory canals are of the *Mesostoma* type. The excretory vesicle is exactly or approximately I-shaped. It is surrounded with cells having large-granuled plasm in many species. Excretory formula, $2[(3 + 3 + 3) + (3 + 3 + 3)] = 36$.

(2) There is a stiletto in the oral sucker. Unlike *Xiphidiocercariae* its hilt is full.

(3) There are a pair of large pigmentary eyes at the height of the pharynx.

(4) The penetrative glands are fine-granuled, hardly visible and few (three to five pairs).

(5) Cystigenous glands present.

(6) There are glands in the ventral sucker.

(7) The structure of the tail varies; it is furnished with a dorso-ventral fin in some, with a cuticular case in others, while in still others there is no cuticular differentiation.

(8) The cercariae develop in rediae. The rediae have no intestine, collar, procruscule or sexual opening.

(9) They develop in *Lamellibranchiata.*

Nothing but the presence of the spine relates them to *Xiphidiocercariae.* Yet morphological differences, a different type of spine, the presence of eyes and of glands in the ventral sucker, the occurrence of rediae and the development in *Lamellibranchiata* all indicate that these differences are essential and that they cannot be associated with *Xiphidiocercariae.*

It follows from the development cycles known so far that they represent the genera *Crepidostomum, Bunodera, Megalogonia* and *Allocreadium.*

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STRESZCZENIE

Autor przeprowadził cykl rozwojowy *Bunodera luciopercae* na drodze eksperymentalnej. Cykl ten potwierdził znajdując w planktonie jeziora eutroficznego (j. Drużno) i jezior mezotroficznych (j. Gołdapiwo, j. Mamry Półn.) żywicieli pośrednich.

Jako żywicieli pierwszych stwierdził małże: *Sphaerium rivicola* i *Sphaerium corneum*, jako żywicieli drugich skorupiaki: *Diaphnia pulex, Simocephalus expinosus, Eurycercus lamellatus* i *Notodromas monacha*.

Doświadczalnie uzyskanymi metacerkariami przeprowadził z pozytywnym wynikiem zarażenie *Acerina cernua* stwierdzając, że znajdowane w naturze metacerkarie należą do cyklu życiowego *Bunodera luciopercae*.

Autor podał opis redii, cerkarii, metacerkarii i prześledził jej zmiany w żywicielu drugim do osiągnięcia przez nią stadium inwazyjnego.

Autor opisał pokrewną *Cercaria isopora* znajdowaną w *Sphaerium corneum* i w *Sphaerium rivicola* oraz podał charakterystykę grupy *Ophthalmoxiphidiocercariae.*